The Effect of Scale, Technique, Composition and Trade Openness on Energy Demand: Fresh Evidence from Malaysia

Muhammad Shahbaz*

Department of Management Sciences,
COMSATS Institute of Information Technology,
Lahore, Pakistan. Email: shahbazmohd@live.com

Md. Mahmudul Alam

Institute for Environment and Development (LESTARI),
National University of Malaysia (UKM), Malaysia
Email: rony000@gmail.com

Gazi Salah Uddin

Department of Management & Engineering,
Linköping University, SE-581 83 Linköping,
Sweden, E-mail: gazi.salah.uddin@liu.se

Loganathan Nanthakumar

Universiti Teknologi Malaysia, Malaysia

*corresponding author

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Abstract: The aim of this paper utilizes an energy demand model to investigate the impact of trade openness on energy consumption by incorporating scale and technique, composition and urbanization effects in the case of Malaysia. The study covers the sample period of 1970-2011 using quarter frequency data. We applied the bounds testing approach in the presence of structural breaks to examine the long run relationship between the variables. The VECM Granger causality is used to detect the direction of causality between the variables. Our findings indicate that growth effect (scale and technique effect) has a positive (negative) impact on energy consumption whereas composition effect stimulates energy demand in Malaysia.. Energy consumption is positively influenced by both from openness and urbanization. This study opens new policy insights for policy making authorities to articulate a comprehensive energy and trade policy to sustain economic growth and improve the environmental quality of Malaysia.

Keywords: Trade Openness, Energy Demand, Malaysia

I. Introduction

Energy utilization plays a crucial role in any modern industrial economy, since it can influence the level of productivity of other underlying production inputs. The debate between energy utilization and the rate of economic growth has been extensive, predominantly since the occurrence of the oil shocks in the 1970s. According to the International Energy Agency has projected that the global primary energy demand will rise by 40% from its 2007 level by 2030 (IEA, 2009). The non-OECD nations collectively will account for over 90% of this increase; their share of global primary energy demand will rise from 52% to 63%. The consumption of fossil fuels by these countries will continue to dominate the energy scenario, accounting for 77% of the global rise; their demand for fossil oil is projected to increase from the 85 million barrels per day in 2008 to 105 million barrels per day in 2030, rising 24% of the demand.

Trade liberalization promotes economic growth through the industrialization. In order to build a sound export oriented industrial sector, energy is the key resources to fulfilled its demand. It is required for the newly industrialized countries to increase their export growth through the specialization in production that will stimulate a higher degree of competition, scale of economics and technology transfer. On the other hand, the role of imports allows the technology transfer and factors of production that will create the energy demand in the country. The discussion explained that trade openness creates the energy demand in three channels such as, growth effect, scale effect and technology effect.

This study may have a comprehensive effort on this topic of the economy of Malaysia and it will five ways contribution to the literature by applying: (i) Both conventional and structural break unit root tests; (ii) The ARDL bounds testing approach to cointegration for the long run relationship between the variables. (iii) OLS and ECM for the long run and short run impacts (iv) The VECM Granger causality approach for a causal relationship is applied.

The rest of the paper is organized as the following. Section 2 outlines the literature review. The data and the underlying methodology are clarified in Section 3. Empirical findings are presented in Section 4 and the last section concludes the paper.

II. Literature Review

In earlier literature on energy economics, there has been a large number of empirical studies on the positive association between energy consumption and the stage of economic growth of the country. Economic development is influenced by the amount of energy usage as well as primary inputs usage (Beaudreau, 1995) in the production function. The intensified interest by the major economic powers of the world to gain a firm foothold on energy based regions across the globe is a testimony to the fact that energy will remain a major focus in the foreseeable future. The battle for such control will also increase as more energy will be needed to meet the demand for future economic growth. On the other hand, there has been an increased pressure from the developed economics to reduce CO₂ emissions in order to reduce the rate of global warming and climate change. Therefore, emerging and industrialized countries are concerned about their negative effects on economic growth caused by the restricted use of energy.

There are a large number of empirical literatures on the relationship between energy consumption and economic growth. Using the annual data from 1948 to 1994, Stern (2000) examined the relationships between income, energy consumption, labor market and capital stocks in the United States of America (USA). He concluded that there is a mutual causality between energy consumption and GDP in the USA. On the other hand, Wolde-Rufael (2005) found conflicting evidences with the neutrality hypothesis supported in a substantial number of countries, with little support for the hypothesis that energy consumption causes economic growth. According to the eighteen developing countries, Lee (2006) found that causality running from energy consumption to economic growth but not vice versa applying the panel cointegration approach. A group of six Gulf Cooperation countries, Al-Iriani (2006) found a unidirectional causality running from economic growth in energy consumption. According to Richmond and Kaufmann (2006) included energy consumption in their analysis and find a relationship between income and energy consumption and emission. Using a tri-variate model, Soytaş and Sari (2006) failed to identify a significant Granger causality link between any of the variables. Recent study by, Lorde et al. (2010) used capital, labor, technology, and energy as separate inputs to test the existence of the long - run relationship between output growth and electrical energy usage and suggested long-run relationship between growth and electricity consumption and bidirectional causality between electrical energy consumption and real GDP in the long-run. However, the causality is unidirectional from energy to the output in the short-run. A study by Latin America, Apergis and Payne (2009) found both short-run and long-run causality from energy consumption to economic growth applying the panel cointegration method. Uddin et al. (2011) supported that unidirectional causality runs from energy consumption to economic in case of Bangladesh. On the contrary, Shahbaz and Lean (2012b) found that economic growth Granger causes energy consumption in Tunisia. Recently, Shahbaz et al. (2012) reported feedback hypothesis between energy consumption and economic growth in Pakistan.

The effect of trade liberalization on energy consumption is relatively new in the energy-income literature. Ghani (2012) argued that trade liberalization may have an effect on energy consumption, because it induces changes in trade policies that are related to energy usage, such as reduction in tariff and non-tariff barriers on energy efficient products. Liberalization may also influence energy consumption indirectly through changes in economic growth, environmental regulations, implementation of ecologically beneficial management practices, reallocation of resources, etc. It is also anticipated that liberalization brings about institutional changes, which affects the transfer of energy-saving technologies that can help to improve energy efficiency.

Trade liberalization may also induce the technique effect indirectly through the increase in income. Higher income is believed to change consumer preferences, inducing the government to reform environmental and energy regulations. Similarly, in another recent study, Sadorsky (2012) explained how export and imports are linked to energy consumption. Export expansion increases the demand for the factors of production (capital, labor, energy) used to make the exports. Once exports are produced, machinery and equipments must be used to load and transport the exports to seaports, airports or other docking stations where the exports are then offloaded and re-loaded for voyages abroad. The machinery and equipments used in the production, processing and transportation of goods for export require energy to operate. An increase in exports represents an increase in economic activities in export oriented sectors and this should increase the demand for energy. Likewise, imported goods can affect the demands for energy in two ways. Firstly, imports are trade flows into a country and this necessitates a well functioned transportation network to move goods around, which requires energy. As a consequence, an increase in trade flows is expected to increase energy consumption. Secondly, the composition of imports can affect energy consumption especially if the imports are energy intensive products like automobiles, dishwashers, air conditioners, etc. It is also possible that energy consumption can affect the flow of imported goods if the imported goods are machinery or equipments that require energy to operate. Energy conservation policies or lack of accessible energy may reduce the usefulness and efficiency of energy-dependent imported goods, making it less likely that such goods will be imported. In both cases, there is also a possibility of a feedback relationship or no statistically significant relationship between imports and energy, and export and energy.

The empirical studies, however, demonstrated inconclusive results on the relationship between trade openness and energy consumption. According to the Narayan and Smyth (2009) for a panel of six Middle-Eastern countries (Iran, Israel, Kuwait, Oman, Saudi Arabia, and Syria) showed short-run Granger causality running from electricity consumption to real GDP and from income to exports. They also found evidence in favor of a long-run Granger causality relationship running from exports and electricity consumption to real income earned from exports and real income to electricity consumption.

In two research papers on almost the similar topic, studying electricity generation and consumption in Malaysia, Lean and Smyth (2010a) found evidence for Granger causality running from electricity generation to exports; however, Lean and Smyth (2010b) did not find any evidence for a Granger causal relationship between exports and electricity consumption. While Lean and Smyth (2010a, 2010b) and Narayan and Smyth (2009) focused on the relationship between exports and electricity, Sadorsky (2011) focussed on the more general relationship between energy consumption and trade (measured by either exports or imports). Sadorsky (2011) for a panel of Middle-Eastern economies (Bahrain, Iran, Jordan, Oman, Qatar, Saudi Arabia, Syria, and United Arab Emirates) found that short-run dynamics show causality running from exports to energy consumption and a feedback relationship between imports and energy consumption. In case of Pakistan, Shahbaz et al. (2013) investigated the relationship between natural gas consumption and economic growth by incorporating exports in the production function. Their results indicated that the variables are integrated for a long run relationship. Natural gas consumption, exports, capital and labour add in economic growth. Natural gas consumption Granger causes economic growth and exports.

Several studies have been conducted recently considering the technique effect, labor-capital composition effect and urbanization effect to determine the energy demands in an

economy. Utilizing the theoretical model of Antweiler et al. (2001), Cole (2006) has modelled empirically the mechanisms through which trade liberalization affected the pattern of national energy consumption on 32 developed and developing countries. The results of this study suggest that per capita energy consumption is subject to a scale effect which, for the mean country, outweighs the negative technique effect, indicating that regulations and technological improvements are not keeping pace with the growth of GNP. With regard to the trade-induced composition effect, evidences have been found to suggest that energy-intensive industries are subject to conflicting forces as postulated by the factor endowment and the pollution haven hypotheses. These results indicate that trade liberalization and per capita energy consumption have a positive correlation. Working on the annual data from 1971 to 2007, Hossain (2011) empirically examined the dynamic causal relationships between CO₂ emission, energy consumption, economic growth, trade openness and urbanization for a panel of nine newly industrialized countries. The results of the study have supported the hypothesis that there is no evidence for long-run causal relationship, but there is a unidirectional short-run causal relationship from economic growth and trade openness to CO₂ emission, from economic growth in energy consumption, from trade openness to economic growth, from urbanization to economic growth and from trade openness to urbanization. These results support the study of Sadorsky (2011) on eight Middle-Eastern countries for the period of 1980 to 2007, showing short-run causality from exports to energy consumption, and a bi-directional feedback relationship between imports and energy consumption.

Studying in seven South American countries for the period of 1980 to 2007, Sadorsky (2012) showed a short-run bi-directional feedback relationship between energy consumption and exports, output and exports and output and imports. Evidences also suggest that there is a one way short-run relationship from energy consumption to imports. In the long-run, a causal relationship has been established between trade (exports or imports) and energy consumption. Ghani (2012), working in 54 developing countries, showed that trade liberalization per se does not affect the growth of energy consumption of the developing countries, but its interaction with capital per labor reduces the growth of energy consumption as capital per labor increases. However, the effect is only significant after a certain minimum threshold level capital per labor is reached. On the other hand, economic growth increases energy consumption and its effect is not conditional upon trade liberalization.

Based on these mixed empirical findings, this paper tries to determine the impacts of trade openness, economic growth, technique effects, labor-capital composition, and urbanization on the energy consumption in Malaysia. Malaysia, an important economic player in East Asia, has successfully pursued a policy of robust economic growth enviable for any emerging nation. However, a significant spurt in energy consumption followed by a concomitant rise in pollutant emissions in recent times has made the choice of the study for this country not only timely but also of much significance. According to the United Nations Development Report, CO₂ emission in Malaysia has increased by 221% in 2004 compared to the emission level of 1990. The report lists Malaysia at 26th among the top 30 greenhouse gas emitting nations. If the current rate of emission persists and other top greenhouse gas emitters improve their energy consumption efficiency, Malaysia may move up the ladder. The fact that Malaysia is a signatory to Kyoto Protocol did little to alter the pattern of the rapid growth in emissions (Liebman, 2007). However, the several initiatives taken by the government to promote renewable energy and to reduce CO₂ emission are reassuring. Therefore, the findings of the energy demand model will help policymakers choose appropriate strategies for sustainable economic growth in Malaysia.

Recent study by, Islam et al. (2013) working in Malaysia suggested that energy consumption is influenced by economic growth and financial development, both in short-run and long-run, but the population-energy relationship holds only in the long run¹.

III. Data, Model Construction and Estimation Strategy

The data on energy consumption per capita (kt of oil equivalent), CO₂ emissions per capita (metric tons per capita), real capital stock, real trade (exports + imports), labor force, urbanizing population as share of total population has been obtained from world development indicators (CD-ROM, 2012). The present study has covered the time period of 1970-2011. We have used series of population to transform the data into per capita. The series are converted into a natural log form.

We follow Cole, (2006); Kneller et al. (2008); Ghani, (2011, 2012) to examine the impact of trade openness on energy demand using quarter frequency data over the period of 1970-2011 in the case of Malaysia. The empirical equation is modeled as following:

$$E_t = f(Y_t, Y_t^2, KL_t, TR_t, U_t) \quad (1)$$

We apply log-linear model². Our empirical model is articulated as follows:

$$\ln E_t = \beta_1 + \beta_2 \ln Y_t + \beta_3 \ln Y_t^2 + \beta_4 \ln KL_t + \beta_5 \ln TR_t + \beta_6 \ln U_t + \mu_t \quad (2)$$

Where, $\ln E_t$, $\ln Y_t$, $\ln Y_t^2$, $\ln KL_t$, $\ln TR_t$ and $\ln U_t$ is natural log of energy consumption per capita, real GDP per capita, real GDP per capita square, capital-labor ratio per capita, trade openness (exports + imports) per capita and urbanisation per capita. Y_t indicates economic growth effect, scale and technique effect is captured by Y_t^2 , KL_t represents composite effect, trade openness is shown by TR_t , urbanisation effect is indicated by U_t and E_t is for energy use. μ_t is error term expected to be independently identically distributed. We expected that $\ln Y_t > 0$, $\ln Y_t^2 < 0$, $\ln K_t.L_t > 0$, $\ln TR_t > 0$ and $\ln U_t < 0$.

II.I Zivot-Adndrews Unit Root Test

Historically, in order to test stationarity properties of the variables unit root tests like ADF by Dickey and Fuller (1979), P-P by Philips and Perron (1988), KPSS by Kwiatkowski et al. (1992), DF-GLS by Elliott et al. (1996) and Ng-Perron by Ng-Perron (2001) have been used extensively. However, due to lack of information on structural breaks stemming in the series, these tests produce unreliable results. To remove this anomaly Zivot and Adndrews, (1992) suggested another model that allows to accommodate single structural break point in the variables at level form, in slope of trend component, and in intercept and trend function. Using Zivot-Andrews, (1992) model the structural break in the series can be tested as:

¹ Tang and Tan, (2012) also reported bidirectional causality between financial development and energy consumption in case of Malaysia

² See Shahbaz and Lean (2012a, b) and Shahbaz et al. (2012) for more details

$$\Delta x_t = a + ax_{t-1} + bt + cDU_t + \sum_{j=1}^k d_j \Delta x_{t-j} + \mu_t \quad (1)$$

$$\Delta x_t = b + bx_{t-1} + ct + bDT_t + \sum_{j=1}^k d_j \Delta x_{t-j} + \mu_t \quad (2)$$

$$\Delta x_t = c + cx_{t-1} + ct + dDU_t + dDT_t + \sum_{j=1}^k d_j \Delta x_{t-j} + \mu_t \quad (3)$$

where DU_t denotes dummy variable and gives the mean shift incurred at each point while DT_t denotes trend shift variable.

$$DU_t = \begin{cases} 1 \dots \text{if } t > TB \\ 0 \dots \text{if } t < TB \end{cases} \text{ and } DT_t = \begin{cases} t - TB \dots \text{if } t > TB \\ 0 \dots \text{if } t < TB \end{cases}$$

The null hypothesis of unit root break date is $c = 0$ which indicates that series is not stationary with a drift not having information about structural break stemming in the series while $c < 0$ hypothesis implies that the variable is found to be trend-stationary with one unknown time break. Zivot-Andrews unit root test fixes all points as potential for possible time break and does estimation through regression for all possible structural breaks successively. Then, this unit root test selects that time break which decreases one-sided t-statistic to test $\hat{c} (= c - 1) = 1$. Zivot-Andrews intimate that in the presence of end points, asymptotic distribution of the statistics is diverged to infinity point. It is necessary to choose a region where the end points of sample period are excluded. Further, Zivot-Andrews suggested the trimming regions i.e. (0.15T, 0.85T) are followed.

II.II The ARDL Bounds Testing Approach

Since traditional approaches to cointegration have certain demerits, we have used the structural break autoregressive distributed lag model or the ARDL bounds testing approach to cointegration in the presence of structural break stemming in the series. The ARDL bounds testing approach to cointegration has certain merits like it is flexible regarding integrating order of the variables whether variables are found to be stationary at I(1) or I(0) or I(1) / I(0). In addition, Monte Carlo investigation confirms that this approach is better suited for small sample size (Pesaran and Shin, 1999). Moreover, a dynamic unrestricted error correction model (UECM) can be derived from the ARDL bounds testing through a simple linear transformation. The UECM integrates the short run dynamics with the long run equilibrium without losing any information for the long run. The empirical formulation of the ARDL bounds testing approach to cointegration is given below:

$$\begin{aligned}
\Delta \ln E_t = & \alpha_1 + \alpha_T T + \alpha_E \ln E + \alpha_Y \ln Y_{t-1} + \alpha_{Y^2} \ln Y_{t-1}^2 + \alpha_{K/L} \ln KL_{t-1} + \alpha_{TR} \ln TR_{t-1} \\
& + \alpha_U \ln U_{t-1} + \sum_{i=1}^p \alpha_i \Delta \ln E_{t-i} + \sum_{j=0}^q \alpha_j \Delta \ln Y_{t-j} + \sum_{k=0}^r \alpha_k \Delta \ln Y_{t-k}^2 + \sum_{l=0}^s \alpha_l \Delta \ln KL_{t-l} \quad (4) \\
& + \sum_{m=0}^t \alpha_m \Delta \ln TR_{t-m} + \sum_{n=0}^t \alpha_n \Delta \ln U_{t-n} + \mu_t
\end{aligned}$$

Where, $\ln E_t$, $\ln Y_t$, $\ln K/L_t$, $\ln TR_t$ and $\ln U_t$ labortes natural log of energy consumption, natural log of real GDP per urbanization, natural log of capital-labour ratio, natural log of trade openness per capita and natural log of urbanisation per capita. Δ is for difference operator and μ_t denotes residual term. F-statistics are computed to compare with upper and lower critical bounds generated by Pesaran et al. (2001) to test for existence of cointegration. The null hypothesis to examine the existence of the long run relationship between the variables is $H_0 : \alpha_E = \alpha_Y = \alpha_{K/L} = \alpha_{TR} = \alpha_U = 0$ against alternate hypothesis ($H_a : \alpha_E \neq \alpha_Y \neq \alpha_{K/L} \neq \alpha_{TR} \neq \alpha_U \neq 0$) of cointegration for equation-4. Using Pesaran et al. (2001) critical bounds, if computed F-statistic is more than upper critical bound (UCB) there is cointegration between the variables. If computed F-statistic does not exceed lower critical bound (LCB) the variables are not cointegrated for a long run relationship. If computed F-statistic falls between lower and upper critical bounds then decisions regarding cointegration between the variables is uncertain. However, since our sample size is large (160 observations) and critical bounds generated by Pesaran et al. (2001) may be suitable. Therefore, we use lower and upper critical bounds developed by Pesaran et al. (2001) rather than Narayan (2005).

II.III The VECM Granger Causality Approach

We should apply the vector error correction model (VECM) to investigate the causal relationship between the variables once cointegration relationship exists between the series. It is argued by Granger, (1987) that the VECM is an appropriate approach to examine causality between the variables when series are integrated at I(1). The empirical equation of the VECM Granger causality approach is modelled as follows:

$$\begin{aligned}
(1-L) \begin{bmatrix} \ln E_t \\ \ln Y_t \\ \ln Y_t^2 \\ \ln KL_t \\ \ln TR_t \\ \ln U_t \end{bmatrix} &= \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ \alpha_5 \\ \alpha_6 \end{bmatrix} + \sum_{i=1}^p (1-L) \begin{bmatrix} b_{11i} & b_{12i} & b_{13i} & b_{14i} & b_{15i} & b_{16i} \\ b_{21i} & b_{22i} & b_{23i} & b_{24i} & b_{25i} & b_{26i} \\ b_{31i} & b_{32i} & b_{33i} & b_{43i} & b_{53i} & b_{36i} \\ b_{41i} & b_{42i} & b_{43i} & b_{44i} & b_{45i} & b_{46i} \\ b_{51i} & b_{52i} & b_{53i} & b_{54i} & b_{55i} & b_{56i} \\ b_{61i} & b_{62i} & b_{63i} & b_{64i} & b_{65i} & b_{66i} \end{bmatrix} \times \begin{bmatrix} \ln E_{t-1} \\ \ln Y_{t-1} \\ \ln Y_{t-1}^2 \\ \ln KL_{t-1} \\ \ln TR_{t-1} \\ \ln U_{t-1} \end{bmatrix} \\
&+ \begin{bmatrix} \alpha \\ \beta \\ \delta \\ \phi \\ \theta \\ \vartheta \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \end{bmatrix}
\end{aligned} \tag{6}$$

Where $(1-L)$ indicates difference operator and lagged residual term is indicated by ECT_{t-1} which is obtained from long run relationship while $\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}$, and ε_{5t} are error terms. These terms are supposed to be homoscedastic i.e. constant variance. The statistical significance of the coefficient of lagged error term i.e. ECT_{t-1} usithe long run causal relationshipn causal relationship between the variables. The short run causality is shown by statistical significance of F-statistic using Wald-test by incorporating differences and lagged differences of independent variables in the model. Moreover, the joint significance of the lagged error term with differences and lagged differences of independent variables provides joint long-and-short runs causality. For example, $b_{12,i} \neq 0 \forall_i$ implies that economic growth Granger-causes CO₂ emissions per capita and economic growth is Granger cause of CO₂ emissions per capita shown by $b_{21,i} \neq 0 \forall_i$.

IV. Results and their Discussions

The primary step is to test the unit root properties of the variables to proceed for the ARDL bounds testing approach to cointegration. The ARDL bounds testing approach is free from pre-unit root testing but we ensure that none of the variables is integrated at I (2). The bounds testing assumes that variables should be stationary at I(0) or I(1) or I(0)/I(1). So to overcome this issue, we have applied traditional unit root tests such as ADF test by Dickey and Fuller (1981), PP test by Philips and Perron (1981) and DF-GLS test by Elliott et al. (1996). The results of these unit root tests are reported in Table-1. The results show that energy consumption, income, capital-labor ratio, trade openness and urbanization have a unit root problem at level with intercept and trend. This series is found to be stationary at 1st difference. This shows that the variables have unique order of integration.

Table-1: Unit Root Analysis

Variables	ADF	PP	DF-GLS
$\ln E_t$	-2.0780 (9)	-2.0807 (9)	-2.6542 (3)

$\Delta \ln E_t$	-4.5032 (8)***	-4.5032 (9)***	-10.4149 (3)***
$\ln Y_t$	-1.9093 (6)	-1.0571 (6)	-1.3670 (5)
$\Delta \ln Y_t$	-4.6320 (6)***	-4.6320 (6)***	-4.6135 (6)***
$\ln KL_t$	-1.7590 (4)	-1.7852 (12)	-1.8756 (1)
$\Delta \ln KL_t$	-4.2119 (4)***	-4.1736 (6)***	-6.1110 (6)***
$\ln TR_t$	-0.0854 (9)	0.0914 (1)	-0.1797 (4)
$\Delta \ln TR_t$	-3.5589 (8)**	-6.0791 (6)***	-3.3142 (4)**
$\ln U_t$	-0.3421 (8)	1.0792 (3)	-1.4042 (9)
$\Delta \ln U_t$	-4.8665 (10)***	-4.6162 (12)***	-3.5619 (3)***
Note: *** and ** denote the significance at 1% and 5% levels respectively. Figure in the parenthesis is the optimal lag structure for ADF and DF-GLS tests, and bandwidth for the PP test.			

Table-2: Zivot-Andrews Structural Break Unit Root Test

Variable	At Level			At 1 st Difference		
	T-statistic	Time Break	Decision	T-statistic	Time Break	Stationary
$\ln E_t$	-4.705 (1)	1993Q2	Unit root exists	-12.317 (3)*	1978Q3	Stationary
$\ln Y_t$	-4.311 (2)	1991Q2	Unit root exists	-8.271 (3)*	1986Q3	Stationary
$\ln KL_t$	-4.700 (2)	1997Q2	Unit root exists	-7.181 (2)*	1997Q2	Stationary
$\ln TR_t$	-3.231 (1)	1992Q2	Unit root exists	-8.534 (3)*	1987Q2	Stationary
$\ln U_t$	-3.102 (2)	2000Q2	Unit root exists	9.723 (3)*	1989Q2	Stationary
Note: * represents significant at 1% level. Critical T-values are -5.57 and -5.08 at 1% and 5% levels respectively. Lag order is shown in parenthesis.						

These unit root tests may provide misleading results regarding stationary properties of the variables. The reason is that these unit root tests do provide information about structural breaks arising in the series. The information about structural breaks in the series would enable policy makers to analyze the impact of major economic policies and help them in articulating a comprehensive economic, energy as trade policy to sustain long run economic growth. The issue is resolved by applying Z-A unit root test which accommodates information about one unknown structural break occurring in the series. The results of Z-A unit root test are pasted in Table-2. The results disclose that variables are non-stationary at level but integrated at order 1 i.e. I(1). This exposes that we should apply the ARDL bounds test approach to examine long run association between the variables.

Table-3: Lag Order Selection

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	2176.286	NA	6.66e-20	-27.1285	-27.0132	-27.0817
1	4456.584	4361.070	4.36e-32	-55.1823	-54.3757	-54.8545
2	4736.099	513.6086	2.08e-33	-58.2262	-56.7270*	-57.6174

3	4761.973	45.6022	2.38e-33	-58.0996	-55.9086	-57.2099
4	4772.083	17.0603	3.31e-33	-57.7760	-54.8930	-56.6053
5	4938.858	268.9250	6.55e-34	-59.4107	-55.8358	-57.9590
6	5046.284	165.1682*	2.74e-34*	-60.3035*	-56.0367	-58.5709*
7	5056.361	14.7371	3.91e-34	-59.9795	-55.0208	-57.9659
8	5062.527	8.5551	5.91e-34	-59.6065	-53.9559	-57.3120
* indicates lag order selected by the criterion LR: sequential modified LR test statistic (each test at 5% level) FPE: Final prediction error AIC: Akaike information criterion SC: Schwarz information criterion HQ: Hannan-Quinn information criterion						

According to the ARDL approach, lag order of the variables is important for the model specification. Table-3 indicated the lag length criterion. In this paper, we followed Akaike information criteria to select an appropriate lag length. It is pointed by Lütkepohl, (2006) that AIC has superior power properties for small sample data compared to any lag length criterion. Akaike information criterion provides efficient and consistent results as compared to final prediction error (FPE), Schwarz information criterion (SBC) and Hannan-Quinn information criterion (HQ). Based on empirical evidence provided by AIC, we find that the optimum lag is 6 in such quarter frequency data over the period of 1970-2011 in the case of Malaysia.

Tabel-4: The ARDL Bounds Testing Analysis

Estimated Model	$F_E(E_t / Y_t, KL_t, TR_t, U_t)$	
Optimal Lag Length	(6, 6, 5, 6, 6, 5)	
F-statistics	4.757**	
Critical values [#]	Lower Critical Bound	Upper Critical Bound
1 per cent level	3.60	4.90
5 per cent level	2.87	4.00
10 per cent level	2.53	3.59
R^2	0.7521	
Adjusted- R^2	0.6715	
F-statistics	9.33666*	
Durbin-Watson	1.9626	
Diagnostic Tests		
Test	F-statistic	Prob-value
χ^2_{SERIAL}	1.4828	0.2311
χ^2_{ARCH}	0.4813	0.6188
χ^2_{WHITE}	0.2332	0.7668
χ^2_{REMSAY}	1.2363	0.2684
Note: * denotes the significance at 1% level respectively. The optimal lag structure is determined by AIC.		

The results of bounds testing are detailed in Table-4. Our empirical evidence opines that the calculated F-statistic exceeds the upper critical bound at the 5% level of significance. This

concludes that we may reject the null hypothesis of no cointegration. The results reported on Table-4 show that there is evidence of cointegration once we treated income, factor endowment, trade openness and urbanization as predictor variables. This shows that there exists a long run relationship between trade openness and energy consumption in the case of Malaysia over the period of 1970-2011.

Log run model fulfills the assumptions of the classical linear regression model (CLRM) such as serial correlation, autoregressive conditional heteroskedasticity as well as white heteroskedasticity and specification of the model. Our results find that evidence of no serial correlation is found. The autoregressive conditional heteroskedasticity and white heteroskedasticity are not found. Finally, the bounds testing model is articulated well as confirmed by Ramsey RESET tests.

The next turn is to find the impact of independent actors on the dependent variable. The results show that income has a positive impact on energy consumption. This shows that income effect is more elastic for energy consumption and it is statistically significant at the 1% level of significance. A 1% increase in income is linked with 1.9980% energy consumption. Due to the vision 2020 to become a developed nation, the Malaysian economy is growing very fast. Like other developed countries, the consumption patterns of people are moving more towards the technological usage. Moreover, better financial growth and credit facilities are leading to more use of energy. Further, due to the high subsidy and lower price of fuel, people tend to use more vehicles and household machineries. Therefore, energy reduction policies will have less impact on economic growth here.

The impact of scale and technique effect on energy consumption is negative and significant at 5% significance level. This implies that economies of scale and adoption of advanced technology saves energy by 0.3036%. Therefore, energy consumption policies should be driven based on the adoption of advanced technologies and achieving economies of scales, especially in the industrial and manufacturing production level. The impact of capital-labor ratio (composite effect) has a positive impact on energy demand and it is statistically significant at the 10% level of significance. It implies that keeping other things constant, a 1% increase in capital-labor ratio is linked with energy use by 0.0474%. Due to this highly inelastic nature of a composite effect on energy demand, emphasizing on the usage of more capital in terms of labor or capital intensive production will lead to a very low increase of energy usage. Based on the technique and composition effects, Malaysia should increase and focus more on advanced energy saving technologies to control its high usage of energy.

The positive and statistically relationship is found between trade openness and energy consumption. We find that a 0.0617% increase in energy consumption is related to 1% increase in trade openness, all else is same. Generally, in a low-income country an increase in trade openness will increase their energy usage, but in a high-income country energy usage falls in response to trade liberalization. As Malaysia is a growing economy, the energy consumption shows an inelastic nature in response to trade openness. Therefore, emphasizing on more openness in trade will lead to very low level of increase in energy usage. Thus, trade expansion policies like export promotion policies designed to increase exports will not increase energy consumption here. Another implication of the findings is that environmental policies that reduce energy consumption will not affect the growth in exports. The impact of urbanization on energy consumption is positive and significant at 1% significance level. We infer that a 1% urbanization raises energy demand by 0.8188% by keeping other things constant. Due to the vision 2020 to become a developed nation, the countryside is growing rapidly with the urban facilities. At the

same time, infrastructural advancement causes the expansion of urban areas. The growing income facilities in rural areas are also leading to more use of technology. Eventually, the urbanization effect causes an increase in the energy consumption in the Malaysian society.

Table-5: Long-and-Short Runs Analysis

Dependent Variable = $\ln E_t$			
Long-Run Results			
Variable	Coefficient	Std. Error	T-Statistic
Constant	-2.2585*	0.7545	-2.9932
$\ln Y_t$	1.9980*	0.6764	2.9538
$\ln Y_t^2$	-0.3036**	0.1321	-2.2966
$\ln KL_t$	0.0474***	0.0263	1.8015
$\ln TR_t$	0.0617**	0.0283	2.1800
$\ln U_t$	0.8188*	0.1976	4.1437
R^2	0.9909		
F-statistic	35.6064*		
Short-Run Results			
Variable	Coefficient	Std. Error	T-Statistic
Constant	-0.0024	0.0020	-1.2098
$\ln E_{t-1}$	0.4548*	0.0634	7.1654
$\ln Y_t$	-6.5693*	2.4965	-2.6313
$\ln Y_t^2$	0.3837*	0.1336	2.8718
$\ln KL_t$	0.0954**	0.0413	2.3095
$\ln TR_t$	-0.1276***	0.0704	-1.8115
$\ln U_t$	2.5121	1.8945	1.3259
ECM_{t-1}	-0.1774*	0.0320	-5.5437
R^2	0.4483		
F-statistic	18.1096*		
D. W Test	2.0688		
Diagnostic Tests			
Test	F-statistic	Prob. Value	
$\chi^2 NORMAL$	0.6539	0.7211	
$\chi^2 SERIAL$	0.6447	0.4232	
$\chi^2 ARCH$	1.3588	0.2454	
$\chi^2 WHITE$	1.0538	0.4042	
$\chi^2 REMSAY$	0.7043	0.4026	
Note: *, ** and *** represent significance at 1%, 5% and 10% levels respectively.			

The short run results are also reported in the lower segment of Table-5. The results opine that future energy demand is positively affected by energy demand in the current period at 1%

level of significance. Economic growth declines but the scale and technique increase energy consumption. These findings are statistically significant at the 1% level of significance. The capital-labor ratio has positive and statistically significant impact on energy demand. Trade openness declines energy consumption. Urbanization is also positively linked with energy consumption but it is statistically insignificant. The long run relations between openness and energy consumption established through the lagged error correction term which is negative and significant. The negative sign of the error correction term confirms the expected convergence process in the long-run dynamics of openness and energy consumption in Malaysia. In fact, 18 percent of the last year's disequilibria are corrected in the current year based on these results, suggesting a speed of adjustment in the relationship process following a shock. In order to achieve the stable long run equilibrium energy demand in Malaysia, it would take around five years and two quarters. The results of the diagnostic tests suggest that the underlying desirable assumptions are fulfilled. The short run findings of the empirical results are consistent in order to implement the carbon emissions or environmental policy in Malaysia.

The stability of the ARDL bounds testing estimates is investigated by applying the CUSUM and CUSUMsq tests. The results are shown in Figure-1 and 2. The plots of the CUSUM statistics are well within the critical bounds.

The straight lines represent critical bounds at 5% significance level
Figure-1: Plot of Cumulative Sum of Recursive Residuals

The straight lines represent critical bounds at 5% significance level
Figure-2: Plot of Cumulative Sum of Squares of Recursive Residuals

Table-6: Chow Forecast Test

Forecast from 1983Q1 to 2011Q4			
F-statistic	0.7191	Probability	0.9100

Log likelihood ratio	0.1847	Probability	0.5101
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The plots of the CUSUMsq of squares statistics are not well within the critical bounds. Furthermore, we apply Chow forecast test to examine the significance structural breaks in an economy for the period 1983-1984 due to industrialization in terms of consumer goods and restrictive trade policy. In this study, F-statistics computed in Table-6 suggests that there is no significant structural break in the economy during the sample period. The chow forecast test is more reliable and preferable than graphs (Leow, 2004). This confirms that the ARDL estimates are reliable and efficient.

Conclusion and Policy Implications

Trade liberalization policies reduce or remove the tariff and non-tariff barriers in order to allow the exchange of goods and services without any barriers. In order to implementation of trade liberalization policy in the emerging and industrialized countries, it will attract foreign direct investment that accelerates economic growth through the creating the employment opportunities, transfer technology and improve the welfare in the country. In these processes, there are two types of gains from trade such as static and dynamic. Trade liberalization process helps to create a more competitive market through the reduction of cost due to economies of scale and efficiency. This process is known as the static gains from trade. On the other hand dynamic gains from trade are the transfer and adoption of better management practices and energy-efficient technologies. Trade openness consists of both exports and imports activities can influence the economic growth through the primary inputs in the production process such as energy. Exports-oriented countries will increase the demand for energy utilization for machineries, equipments and transportation of the exports-oriented products. The technology based energy intensive imported products like television, computer, automobile, air-conditioner and washing machines are increasing the demand for energy. According to the endogenous growth theory, imports-trade can be a potential channel to influence the economic growth by transferring technology and factors of production. This implies that trade openness enhances energy consumption via exports, imports and foreign direct investment (adoption of advanced energy-efficient technology) etc.

This paper investigated the how much energy demand is affected by trade openness by incorporating economic growth and urbanization in energy demand function in case of Malaysia. Theoretically trade openness affects energy consumption the scale, composition and technique effects influence the growth of energy consumption. We applied the ARDL bounds approach to examine the long run relationship between the variables while dummy variable is included to capture the structural break arising in the series. Our results exposed that in the presence of structural breaks, cointegration exists between the variables. The findings unveiled that income and scale effects have a positive and negative impact on energy demand. The composition of factor of production also adds in energy consumption. Trade openness raises energy demand. A positive relationship from urbanization to energy consumption is found. In the short run, trade openness declines energy consumption and urbanization increases energy demand but it is statistically insignificant.

The Malaysian economy is growing very fast with the vision of a developed nation by 2020. Here economic growth will have high impacts on energy consumption due to more elastic relationship from income to energy consumption. However, due to the inelastic nature of energy

consumption in response to trade openness, emphasizing on more openness in trade will lead to very low level of increase in energy usage. Thus, trade expansion policies like export promotion policies designed to increase exports will not increase energy consumption. Therefore, this paper suggests that in Malaysia the energy consumption policies should be driven based on the adoption of advanced energy saving technologies and achieving economies of scales, especially in the industrial and manufacturing production level.

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